EFFECTS OF COMPOSTEDMUNICIPALWASTE AND ITS LEACHATE ON SOME SOIL CHEMICAL PROPERTIES AND CORN PLANT RESPONSES

SOHEIL ROGHANIAN 1 *, HOSSIEN MIRSYED HOSSEINI 2 , GHOLAMREZA SAVAGHEBI 3 , LEILA HALAJIAN4, MOZHDEH JAMEI5,HASSAN ETESAMI6

1- Department of Soil Science, Faculty of Agriculture, Tehran University, Tehran, Iran.
2- Department of Soil Science, Faculty of Agriculture, Tehran University, Tehran, Iran.
3- Department of Soil Science, Faculty of Agriculture, Tehran University, Tehran, Iran.
4- Departments of Environment, Science and Research Khuzestan Branch, Islamic Azad University, Iran.
5-M.s.c Agro Meteorology, Water and Power Authority, Khuzestan, Iran
6- Department of Soil Science, Faculty of Agriculture, Tehran University, Tehran, Iran
***Corresponding Author Email**: soheil.ro@googlemail.com, hassanetesami@ut.ac.ir

ABSTRACT:

Most of the soils in Iran, located in arid and semiarid region of Asia, have less than one percent organic matter. For improving the organic matter in these soils, organic fertilizers are used, which ameliorate the chemical, physical and microbiological properties of these soils.Considering shortage of manures, application of organic fertilizers like municipal waste leachate and compost, as a rich source of nutrition, is favorable .with regard to the importance of this issue;our research was aimed at evaluating the impact of municipal waste compost (MWC) and municipal waste compost leachate (MWCL) on some soil chemical properties and corn plant responses under greenhouse conditions. To this aim, soil samples were exposed to composted garbage Leachate concentrations of 0,20 ,40 and 60 % (v v-1, MWCL/Water) and compost rates of 0,15,30 and 60 ton ha-1 in greenhouse conditions for 3 months and measured some soil chemical properties and corn plant responses. Municipal waste compost and its leachate increased the amounts of available macro- (N, P, K) and micronutrients [iron (Fe), manganese (Mn), Zn, and Ni] in soil, which in turn enhanced soil productivity and crop yield. Application of municipal waste compost and its leachate significantly increased the levels of EDTA–extractable nickel (Ni) and other elements in the soil. Although municipal waste compost and its leachate increased concentrations of some heavy metals and other nutrients in corn, particularly in 60% (V/V,MWCL/Water) and 60 t ha-1 (MWC) treatments, the concentrations were below the reported critical levels for these metals. Municipal waste compost and its leachate are rich in plant nutrients and OM and are acidic; therefore, they may be used as solid and liquid fertilizers especially in calcareous and low organic matter soils.

Key words: Compost, Corn, Macronutrients, Heavy metals, Micronutrients, Municipal waste leachate.

INTRODUCTION

Using the residues of human consumption, agricultural activities, municipal garbage, plants and animals can improve soil physical and chemical properties and also the fertility and production capacity (Sposito, 1982). Composts represent an important resource to maintain and restore soil fertility and are of great values nowadays, particularly in those countries where the organic matter content of the soil is low (Castaldi et al., 2004). Soil organic matter plays a major role in maintaining soil quality (Pedra et al.,2007).In addition to supplying plant nutrients, the type and amount of soil organic matter influencesseveral soil properties (Arau´jo et al., 2008).

Increasing the soil organic matter improves soil properties, enhances soil quality, and reduces soil erosion, and increases plant productivity and soil microbial biomass. Thus, in the regions where organic matter content of the soil is low,agricultural use of organic compost is recommended for increasing soil organic matter content and consequently to improve and maintain soil quality. Attractive alternative to recycling such wastes, is composting. Composting is a stabilization process through aerobic decomposition of waste, which has been widely used for different types of wastes (Cai et al.,2007). Many studies have generally shown that the application of this material has promoted apositive influence on a wide variety of crops.

Nevertheless, contradictory results of crop yields have been obtained when the fertilizing capacity of compost has been contrasted with those of organic and mineral fertilizers. It has been demonstrated that the application of compost to soil improves some physical properties such as porosity, water-holding capacity and bulk density.

It also promotes buffering capacity of soil and increases the percentage of organic matter and cation exchange capacity. Occasionally, negative aspects can emerge from compost incorporation,such as an increase in organic pollutants and electrical conductivity of soils. In general,compost application to soil has a positive effect on the microbial population and rhizosphere microorganisms and also contributes to the reduction of nematode populations in plants.However, when big doses of compost are used, an inhibitory effect on seed germination may appear.

According to Canellas et al (2001) the use of municipal solid waste (MSW) in agricultural lands can be justified by the need of finding an appropriate destination for waste recycling.However, agricultural application of MSW may present a potential threat to the environment due to the presence of pathogens and several pollutants (i.e., heavy metals or organic pollutants). Also Considerable attention has been paid to the land application of sewage sludge worldwide in recent years. A large volume of leachate is produced in the process of converting solid waste refuse into compost due to the high moisture content of municipal solid waste in Iran.

Municipal waste leachate has been reported to affect soil physical and chemical properties (Khoshgoftarmanesh and Kalbasi, 2002). It promoted soil aggregation, reduced surface crusting, reduced pH in calcareous soils, and increased soil organic matter. In a 2-year study, application of 320 t ha -1 of an animal husbandry sewage effluent with 2.4% dry matter increased corn yield significantly (Sutton et al., 1987). Irrigation with a secondary sewage effluent increased the growth and yield of vegetables (Davis et al., 1988). The yield of plots irrigated with this effluent was as high as plots receiving N,P, and K fertilizers. Application of refuse to soil may increase the heavy metal contents of the soil that may allow transfer of these metals into the plant .This phenomena usually occurs when industrial sludge is used (Farrell and Jones, 2009) or when a high rate of sewage sludge is applied to the soil. The application of Composted Urban garbage and Leachate increases soil organicmatter, N, P and stable aggregates from amended soils. The results also show a positive response of plant growth to application of municipal solid waste compost in soils. However, heavy metals (HMs) such as Cd, Cu, Pb and Zn are found in all MSW compost, and there are obvious concerns about such toxic elements entering the food chain through food crops to which composts have been applied as fertilizer (Gillet, 1992). Use of any organic matter sources, including urban waste compost and leachate (MWL) produced in process of converting solid waste refuses into compost in arid and semi-arid regions like Iran, is very important. With attention to importance of cited issue;The objectives of this greenhouse study with corn plant were to determination (1) if the use of town urban garbage compost and its Leachate as a potential fertilizer will promote plant growth, yield, and nutrient uptake and improve soil chemical properties.(2) Do town urban garbage compost and its Leachate have similar effects on the plant responses and soil properties? And if not, which of them is better for using? (3) Study the effects of Municipal waste Leachate application on accumulation of heavy metals by corn.

MATERIALS AND METHODS

Municipal waste compost leachate (MWCL) Test

An experiment was conducted during 2009 in the experimental greenhouse of university of Tehran, Iran, on loamy soil. The Municipal waste compost and its leachate were collected from an urban waste recycling plant in Tehran. At first, some properties of soil and leachate like EC ,PH ,organic matter ,macro(K,P,N) and Micronutrients (Pb,Cu,Cd,Ni,Mn,Zn,Fe), dissolved anions and cations were measured (Table 1&2).

The experimental design was a completely randomized design (CRD) with four replicates.
The pots including 6 Kg soil and seeds of corn ((*Zea mays L.*) was irrigated with the rate of 0 ,20% , 40% and 60 % of Municipal waste compost leachate by Volume for 8 weeks.

Municipal waste compost (MWC) Test

To conduct this test also a completely randomized design (CRD) with four replicates was used. Municipal waste compost was added at 0, 15, 30 and 60 t ha-1 to 4 Kg soil (the soil used for leachate Test) in pots and mixed thoroughly .then corn seeds *(Zea mays L.*) were sown in each
pot. in the study also some properties of soil and compost like EC ,pH ,organic matter ,macro(K,P,N) and Micronutrients (Pb,Cu,Cd,Ni,Mn,Zn,Fe) ,were measured (Table 1&3).

Plant and soil analysis after applying treatments

At the end of the eight week growth period above ground plant parts were harvested,oven dried, weighed and analyzed for N, P, K, Fe,Cu, Zn, Pb, Ni, Co, Cr, and Cd were determined by wet combustion (Cottenie et al., 1982) and by atomic absorption spectrometry (Perkin–Elmer 3030 AA spectrometer) (Champan and Part, 1961). Before planting and after harvesting of corn, soil samples were collected from surface (0–30cm) in the region, air-dried, and crushed to pass a 2-mm screen before analysis. Soil pH was measured in soil saturation paste on a digital pHmeter.

Available-P content in the soil was determined by a colorimetric method (Olsen and Sommers, 1990) and available-K was extracted with NH4-Ac (flame-photometer method)(Champan and Part, 1961). Available Fe, Mn, Zn,Cu, Pb, Ni, Co, Cr, and Cd were extracted with EDTA (Olsen and Sommers, 1990) and then determined using AAS technique (Champan and Part, 1961).

Statistical analysis

In both experiment, the effects of different treatments on the important plant indexes including root dry weight, root length, stem length and stem dry weight and soil chemical properties were measured and registered and compared with blanks and together. Data were analyzed by analysis of variation using of the statistical analysis system (SAS, version 6.12, 1989). Mean separation showed by Duncan range test ($P=0.05$).

RESULTS AND DISCUSSION

Chemical characteristics of municipal waste compost and its leachate and response of the soil to leachates irrigation:

Table 2 presents the chemical composition of compost leachate. The pH value of leachate was acidic and EC presented very high.The leachate in general also had a high content of P, Na, Ca, K, Mn and especially of Cl, Fe, HCO3-and Mg. the concentrations of compost constituents are nearly high (Table 3)Table 1 presents the chemical composition of the soil before treatment and Table 4 and 5 shows the mean comparison of the chemical composition of the soil after treatment.

The amount of available N, P and K in soil increased as the result of leachate application. The increases were significant for all concentrations, especially for 60 % treatment. The organic carbon(OC) content of the soil, increased with application of leachate. EC with increase of leachate concentrations increased. Municipal waste compost leachate application significantly ($p<0.05$) increased the levels of EDTA-Zn, Fe and Mn in the soil . In general, EC and the majority of anions and cations increased significantly by irrigating with leachates compared with the original soil and even by watering with deionized water compared with the initial soil content.

Irrigating with the different leachate concentrations decreased soil pH significantly.

Application of waste leachate increased the amount of EDTA-extractable Ni in the soil.CaCO3 concentration decreased with increase of the leachate concentration. The Concentration of the majority of anions and cations also increased significantly with increase of the leachate

concentration. The amount of available N, P and K and micronutrient/heavy metal concentrations

in soil increased as the result of waste compost application (Table 5).

Effects of the waste compost and its leachate supply on concentrations of N, P, K and micronutrients /heavy metals and the plant growth and yield

Application of MWC and MWCL increased the amounts of macro- and micro nutrients in the soil, which in turn promoted soil productivity and crop yield. The concentrations of N, P, K and macronutrient elements in the dry matter of the aerial part of the plant are given in Table 6 and 7. The results show a considerable accumulation of macronutrients by the plant tested. The stem height and Dry matter weight,

and also the amounts of nutrient uptake, were highest in 60% of MWCL. Also plant elemental analysis showed major differences between MWCL and non MWCL -treated plants. Effects of the waste compost and its leachate significantly increased Dry matter weight of Corn as compared to the control. The N, P and K content and concentration of micronutrients in plant increased ($p<0.05$) with increase of compost and leachate concentration. The content of concentration of cations was higher in plants exposed to 60 % leachate concentration than in those exposed to 40 % leachate concentrations, which is in accordance with the higher concentration of these elements in 60 % leachate concentration and in the soils watered with them. Corn plants showed significant changes in macronutrient content in response to compost and its leachate concentrations. Amount of the waste compost and

its leachate, significantly increased concentrations of macro and micronutrients in Dry matter, also they had significant effects on concentrations of heavy metals.

Effect of watering with leachate on the soil

Effect of MWCL on some soil chemical properties is shown in Table 4.

Effect of leachate on soil salinity, PH, OC andCaCO3

Soil salinity increased because of dissolved salts and the increase of concentration of applied leachate. The positive relationship of soil EC to MWCL application shows an excess salt content in MWCL. Soil EC values were several times relative to the control, in Higher MWCL concentrations, to levels characterized as

slightly saline that may adversely affect the growth of plant (Lima et al., 2004). The increase

in EC warns against to soil salinization and impaired crop growth. Adding MWCL to soil can decrease soil PH in short period of time. In long time leachate has no effect on soil PH because of the high buffer capacity of the soil (Rahimi,1995). The Municipal compost used had slightly acidic pH, and this property appear to be extremely useful in the case of application on calcareous soils where compost acts as a pH corrector. High amount of organic matter in leachate increased soil organic carbon. Soil CaCO3 decreased due to leachate acidic PH

(Khoshgoftarmanesh and Kalbasi, 2002). Organic matter and pH of the MWCL and compost are the most important factors that control the availability of micronutrients in the soil (Forbes, 1970).

Effect of leachate on soil macronutrients

Remarkable amount of N is available for plant because of organic matter, acidic PH and proper moisture in soil (Zupanc and Zupanc˘ic,2010) and these conditions are provided by leachate . the high amount of P in leachate and its acidic PH increases dissolution and availability of P.added organic matter to soil by leachate increases P dissolution from phosphate complexes with Fe ,Al and Ca complex formation 46.because of high amount of K in leachate and organic matter that increases CEC ,the K amount rises in soil . Those results agree with results of other researchers (Khoshgoftarmanesh and Kalbasi,2002).

Effect of leachate on soil soluble cations

Decreased soil PH increases CaCO3 solution and then soluble Ca rise up. Leachate acidic PH solves minerals including Mg likedolomite and then Mg availability increases in soil solution phase .oxidation and OM spoil produces CO2 that decreases soil PH and increases nutrient solubility like Ca and Mg (Farrell and Jones,

2009). Applying leachate to soil significantly increases the amount of soil soluble Ca, Mg, Na and K (Diaz and Lan, 1994).

Effect of leachate on soil soluble anions (saturated extract)

Municipal waste leachate compost effect on soil Cl, soluble sulfate and soluble bicarbonate is shown in Table 5. With adding leachate to soil,the amount of soil Cl, soluble sulfate and soluble bicarbonate increased and leaching and time passing decreased their amount (Diaz and Lan,1994).

Effect of leachate on soil micronutrients

Decreased soil PH by leachate ,providing proper condition for micronutrients availability, and its high amount of OM ,for its chelating property ,and high amount of available Fe ,Mn and Zn ,increases the micronutrients

available amount in soil .similar findings have been reported (Banin and Narorot, 1981; Lindsay and Norvell, 1978; Vaisman et al., 1981;Trierweiler and Lindsay, 1969). Applied leachate had lack of measurable Cu.

Effect of leachate on soil heavy metals

leachate has some Ni and with its acidic PH increases soil available Ni in short term (Gallardo-Lara and Nogales, 1987). Similar results have also been reported by other investigators (Prechthai et al. 2008; Smith and Hayden, 1984). Applied leachate had lack of measurable Pb and Cd. In general, results have shown that for leachate, each 3 treatments of 20,40 and 60 %(V/V) had significant effect ,at 5% level ,on soil chemical properties like EC ,PH,

organic matter, macro and micronutrients,dissolved anions and cations and between treatments have been observed significant differences .the treatment 60% have shown highest effects on soil properties. Lowering the
pH caused metal ions to be more soluble and thus more available to the plant which includes both micronutrients and heavy metals that are considered pollutants and also plants and animals poisons (Khoshgoftarmanesh and Kalbasi, 2002).
Excess trace elements in MWCL may be an occasional problem for the agricultural application of MWCL, but usually MWCL contains these metals at relatively low concentrations, and all can be adsorbed to the surfaces of soil particles.interpreting of results have shown that municipal waste compost leachate improves fertility of
soils by raising the quantity of macronutrients and micronutrients and other essential elements in soils but to application of it, we should consider the quantity and available forms of heavy metals and their additive effects on soils and also we should consider the excessive quantity of elements and their toxicity such as salinity to soils and plants yield and exert favorable managements.

Effect of compost on soil chemical properties

Compost effect on some soil chemical properties is shown in Table 5.

Effect of compost on soil salinity, PH and OC

In all the treatments there was slightly increased in soil pH. Soil salinity has increased because of compost dissolved salts. Applying compost to soil raised the EC because of Ca, Mg and Cl high amount in compost and it decreased in end of season because of compost dissolved salts leaching by irrigation water (Adani et al., 2006;
Epstein 1975; Lakhdara et al., 2009; Stark and Clapp, 1980). EC increase in cultivated soil was less than uncultivated soil (data have not shown) because of plant cultivating effect and soil dissolved salts using by plant .compost did not have any effect on cultivated soil PH and also did not have any significant effect on uncultivated soil .high amount of OM in compost increased OC in both soil and OC amount in uncultivated soil was higher than cultivated soil because of plan cultivation effect and increase of OM degradation in cultivated soil. Applying compost to soil increases the amount of soil OC (Gallardo-Lara and Nogales, 1987). Incorporation of composts into soil increases the salt content as well as soil electrical conductivity, especially if high doses of
compost are applied, because of the high salinity of composts (Gallardo-Lara and Nogales, 1987). Thus, Guidi et al (1982) showed that when sewage sludges and composts were applied on a sandy loam soil the electrical conductivity increased in all plots, but, in every case, winter rainfall lowered the content of soluble salts to a
level close to that of the control. Chanyasak et al (1982) assumed that the relatively high electrical conductivity after garbage-compost treatment might be one of the main causes of the inhibitory effect on turnip growth caused by high loading of composts. Nevertheless, this disadvantage appears to be less acute than in the case of sewage sludges which easily promote salinization states equal to,or higher than, 4dS/m (Gallardo-Lara and Nogales, 1987) representing a serious risk to the growth of several types of crops (Gallardo-Lara and Nogales, 1987). Keonoh (1978) demonstrated that the continuous application of compost increases organic matter, and in the case of soils with a low organic matter content equilibrium is achieved with five-year treatments. Hoffmann

(1983) conducted long-term field experiments on acid and alkaline soils, and the results in acid soils showed that, by raising municipal compost doses,soil organic matter content was increased from 2% to 6.9%. Aerobic sludge compost plus the organic fraction of urban refuse has also been reported to bring about an increase in organic carbon in the soil (Gallardo-Lara and Nogales, 1987). The incorporation of compost to soil, especially at
high doses, increases the cation-exchange capacity.

Effect of compost on soil macronutrients

Remarkable amount of N is available for plant because of organic matter, acidic PH and proper moisture in soil (Takeda et al., 2009) and these conditions are provided by compost.Because of oxidation and OM degradation in soil a lot of nutrients like P, are going to be available to plant (Gallardo-Lara and Nogales, 1987). Applying compost to soil increases soil available P and similar results has reported by other researchers (Gallardo-Lara and Nogales, 1987).Due to high amount of K in compost and organic matter, increasing CEC, the K amount rises in
soil. The availability of municipal-compost nitrogen is closely related to the maturity of these materials. The addition to soil of immature compost with a C/N ratio above 30 produces abiological blockage of available nitrogen due to the accelerated growth of microflora that use nitrogen for their own development (Gallardo-
Lara and Nogales, 1987). On the other hand,composts with C/N ratios lower than 20 cause a smaller increase in the microflora than those with C/N ratios above 30 (Gallardo-Lara and Nogales,1987), implying that soil nitrogen is not biologically immobilized (Gallardo-Lara and Nogales, 1987). According to Chanyasak and
Kubota (1981) the C/N ratios of sufficiently well composted materials vary widely, from 5 to 20,depending on the type of raw material, and thus the C/N ratio cannot be used as an absolute indicator of compost maturity. The C/N ratio used in the study was suitable. Regarding the effects of compost application on the phosphorus content of soil, studies performed up to the present have given conflicting results. On one hand, field experiments have shown that these compounds contribute towards an increase in the available phosphorus in soil (Gallardo-Lara and Nogales,1987).Several authors have demonstrated the capacity of composts to enrich soil in potassium,
calcium and magnesium. Gallardo-Lara and Nogales (1987) have all indicated that levels of these elements in soil rise with increasing doses of compost.

Effect of compost on soil micronutrients

The Compost high amount of OM, its oxidation and degradation and neutral PH increase micronutrients availability such as Fe, Mn, Zn and Cu in soil (Gallardo-Lara and Nogales, 1987).Similar findings have been reported (Antoniadis and Alloway, 2003).

Effect of compost on soil heavy metals

Compost may increases heavy metals amount in soil as it increases essential nutrients amount in soil. Increased Heavy metals amount such as Pb ,Cd and Ni by compost have been reported(Ben Achiba et al., 2009). Difference
between available Cd and Ni in cultivated and uncultivated soils is not significant (data have not shown) and they also did not absorb by plant.Richness in essential plant

micronutrients is one of the main characteristics of town waste compost.Gallardo-Lara et al (1984) conducted greenhouse investigations and, at the post harvest, found that increasing application of town refuse compost linearly increased the residual extractable Zn in two soils of different fertility, while similar effects for Fe were recorded in the low-fertility soil, but not in the other soil. The most important sources of these toxic elements are industrial wastes and wastewaters. It would, therefore, be advisable to exclude these residues from the public collection of garbage and avoid their mixture with innocuous municipal wastes (Gallardo-Lara and Nogales,1987).The potential hazards associated with the
heavy-metal contamination of soils tend to increase with time. This may be caused by a decrease in soil pH, especially when the nitrogen and sulphur contents of the waste products are high and the lime content low (Gallardo-Lara and Nogales, 1987). In relation to the application of composted residuals to soil, the main elements generally of concern include: Zn, Cu, Ni, Cd, Pb,Cr and Hg (Stephen, 2009) because they are potentially present in compost in amounts that may be greater than the background values in the
receiving soil.

Effect of compost and its leachate on corn yield

Effect of compost and its leachate on mean corn stem height, total dry weight is presented in Table 6 and 7. Compost is a rich source of essential nutrients that improves plant yield and growth. Including remarkable amount of nutrients, compost increases available form of nutrients for plant in soil and then increases root growth and nutrient uptake by plant that results in plant stem height and Dry weight rise up. Similar findings have been reported by other researchers (Sutton et al., 1987; Lima et al., 2004). Several authors have verified the effects of composts or of compost extracts on seed germination (Gallardo-Lara and Nogales, 1987). No negative effects should appear if the doses used are not excessively high. However, when greater doses
are applied, several plants present different degrees of sensitivity towards the depression of germination caused by the application of these organic materials. In this study, in all concentrations haven't seen any inhibitory effects on plant. Wong & Chu (1985) postulated that the contents of ammonia, ethylene and heavy metals in compost were inversely correlated with seed germination and root elongation of different crops.
Because the ammonia and ethylene oxide contents declined with age of compost (Wong, 1985), it was concluded that compost should be stored at least 115 days before being applied to crops. The compost used in this study has also been stored several months before using.

Effect of compost and its leachate on corn macronutrients

Compost high amount of N, P and K, results in their amount increasing in soil and then their uptake rising up by plant. Compost with providing proper conditions like adjusted PH, high amount of P and OM, increases phosphate compounds solubility, that result in available P increasing in soil and then P amount uprising in plant. Applying compost to soil increases N, P and k uptake by plant (Gallardo-Lara and Nogales,1987). Application of compost and its leachate increased residual availability of the micronutrients in the soil. This was probably due

to the high OM content and acidic pH of the leachate (Higgins, 1984). The marked increase in residual available P is probably due to the OM content and acidity of the leachate which could enhance the availability of native soil P (Rahimi,1995).The incorporation of these derivatives of waste leads to significant increases in plant
potassium content (Gallardo-Lara and Nogales,1987). This tendency also appears when results are expressed in terms of the amount of potassium extracted by the plant (Hortenstine and Rothwell,1973). Generally, it has been claimed that potassium is present in compost in an easilyassimilated form. Hortenstine & Rothwell (1973) found that the addition to soil of 512 metric tones of compost per hectare resulted in the extraction of 50 times more K by millet crops when compared to control crops. In another study these same authors (Gallardo-Lara and Nogales, 1987) deduced that sorghum crops recover 74-98% of the potassium present in compost. With regard to
the effects of these products on the concentration of calcium and magnesium in plants, according to Gallardo-Lara and Nogales 1987, no significant changes are observed. Data relative to the total amount of calcium and magnesium extracted by crops show that increases are produced by the addition of compost, although these effects are always less pronounced than in the case of potassium (Gallardo-Lara and Nogales, 1987). As
previously described, incorporation of compost to soil to yield a C/N ratio above 30 results in the immobilization of soil nitrogen, which originates a deficiency of this element in plants. This effect has been demonstrated in several crops, such as corn, tobacco, radish, oats, sorghum and turnip(Gallardo-Lara and Nogales, 1987). These
deficiencies may be corrected by the addition of nitrogenized mineral fertilizers (Gallardo-Lara and Nogales, 1987). On the other hand, massive addition of these materials to agricultural land appears to increase significantly the amount of nitrogen absorbed, although salinization of soil may also occur (Hortenstine and Rothwell, 1973).Bengtson & Cornette (1973) indicate that the
addition of composts to soil does not produce significant changes in plant phosphorus concentration; producing, at most, slight increases in the amount of this nutrient when high doses of compost were used (Gallardo-Lara and Nogales, 1987).Data concerning the amount of phosphorus absorbed reflect progressive increases promoted by increasing doses of this material (Hortenstine and Rothwell, 1973).

Effect of compost on corn micronutrients

Effect of compost on corn Fe ,Mn, Zn and Cu is displayed in Table 8.compost PH amendment and it ,s high amount of Fe ,Mn ,Zn,Cu and OM ,in which increases micronutrient compounds solution in soil ,results in micronutrient amount increasing in soil and then their absorb rising up by plant. Applying compost to soil increases Fe, Mn, Zn and Cu absorption by plant (Sterrett and Chaney, 1982). Lowering the pH caused metal ions to be more soluble and thus more available to the plant which includes both micronutrients and heavy metals that are considered pollutants and also plants and animals poisons (Khoshgoftarmanesh and Kalbasi, 2002).

Organic matter and pH of the GL are the most important factors that control the availability of
micronutrients in the soil (Forbes, 1970). The incorporation of composts to soil produces a

considerable enhancement of the plant absorption of Zn, Cu and B. Nogales et al (1985b) havedescribed increases in the content of zinc in different plant species, although toxic effects havebeen observed. Increases in copper have been described in plants. The same effect wasdemonstrated in a field test, although, in this case,increases in the concentration of copper weredetected in corn plants but not in other cereals.The addition of compost to soil does not promote significant changes in the amount of iron in plants, leading, at most, to a slight reduction (Gallardo-Lara and Nogales, 1987).

Effect of compost and its leachate on corn heavymetals

Ni and Cd amount were not measurable in plant. Pb high amount in compost increased it in soil

and then its amount in plant. Toxic effect of Pb can result in plant growth decreasing (Pan et al., 2010).Applying compost to soil increases Pb uptake by plant (Sterrett and Chaney, 1982). The application of large quantities of compost and leachate may contaminate soils with heavy metals or other toxic elements. Nevertheless, only some of these elements appear to be absorbed by the plant in great quantities. Thus, King et al (1977) in a study of corn, reported an increase in the

amount of absorbed cadmium but not in the amounts of Cr, Ni or Pb. Mortvedt and Giordano (1975) obtained similar results for chromium in maize crops. The incorporation of compost has also been noted to cause increases of cadmium in other types of crops (potatoes,sugar cane, wheat, barley and oats) although no changes were observed in the amounts of Hg, Ni, Cd and Pb

(Gallardo-Lara and Nogales, 1987). There is a wide range of concentrations of leachate constituents, which may be influenced by a number of waste- and sitespecific factors, such as refuse composition, age of the landfill and climate. According to Andersson (1977),some heavy metals added to soils in the form of soluble salts appear to be more available to the plant than when administered as municipal residues, as in this latter case they are retained by the organic material. For this reason, the possibilities of contamination from compost are small unless extreme circumstances, such as application of very high doses of compost or very acidic

soil pH values, exist. Gray & Biddlestone (1980), in their trace metal analyses of composts and soils, showed that municipal composts carry high levels of some trace metals, e.g. Pb, Zn and Cu, and that they greatly increase the total and extractable levels in soils to which they are applied. However, the availability of these metals to crops is low. For compost effects on soil and

corn, results have shown that each 3 treatments of (Korcak, 1980) and 60 t ha-1 had significant effect ,at 5% level, on soil chemical properties like EC, pH , organic matter, macro and micronutrients and corn properties like yield, wet matter , dry matter , macro and micronutrients. Significant differences have been observed between treatments and the treatment 60 tha-1

have shown highest effects on soil and corn properties.explanation of results have demonstrated that compost improves fertility of soils and corn yield and growth by raising the quantity of macronutrients and micronutrients and other essential elements in soils and corn but to apply these kind of fertilizers we should notice the quantity and available forms of heavy metals and their additive effects on soils and plants like corn and also we should notice the excessive quantity of elements and their toxicity and salinity to soils and plants yield like corn and use favorable managements. In general, The content of several ions in the compost and its leachate is of potential nutritional value to plants, especially when the heavy metals content are low, but high concentrations of some ions can potentially increase salinity soils. the potentially pollutant ions to increase soil salinity in the compost and its leachate tested can be Cl, HCO3 -, Ca, Mg, Na

and K . The Na content was of greater interest since it is an important contributor to soil salinity and the Na concentrations in the compost and its leachate tested had the highest cation content. The results show that the salt content in the soils under compost and its leachate treatments increased proportionally with the respective salt concentration. EC in soils under the compost and its leachate treatments exceeds the threshold level (4 dSm-1EC). Increased soil salinity reflected increased the compost and its leachate salinity and the magnitude of the increase depends on the salt concentration in the compost leachate. Similar results with regard to increases in K, P, Mg contents and especially the Na content was published by (Bramryd, 1988) for soil samples of plots irrigated with leachates. A significant increase in soil salinity was also found with waste water irrigation, where a strong correlation (r=0.98) existed between the salinity of irrigation water and the resultant soil salinity (Al-Jaloud, 1992). The soil-solution composition of various mixtures of landfills sewage sludges from and basic soils also present a noticeable increase of EC. K, Ca, Mg and Na (Hue et al., 1993).The salinity of the soils contaminated by leachates from

landfills may have a negative effect in semi-arid areas where salinity problems are not uncommon. In such areas with little rain and high evaporation, the excessive salt content of the soil is not easily leached (Hernttndez et al., 1999). Researchers report that soil salinity has anegative effect on microbial respiration, especially when NaCI is responsible for the salinity. They further indicate that salinization negatively affects biological and biochemical fertility of calcareous soils with a negative influence on some hydrolyses microbial respiration as well as the nitrate and carbonate content.This means that the microbial activity of a soil and the cycle of important nutrients, such as P, N and C, are harmed by the continuous salinization of the soils when saline water is used for irrigation (Lima et al., 2004) .There was significant difference in the yield response with the application of compost and leachate treatments.The increase in cations in the soils as a consequence of leachate irrigation and placation of compost was clearly reflected by the content of those elements in the plant.The Na content was the most affected nutrient. Macroand micronutrient contents increased in the plants with leachate and compost concentrations. Such increase in the cation content in the plants is one of the important aspects that must be taken into account when compost and leachate are used as irrigation fertilizer because high concentrations of cations in the plant tissue may inhibit some biochemical processes (Hernttndez et al., 1999). Briefly, soil salinity from leachate irrigation causes alterations in the nutrients uptake, which can vary considerably leading to the accumulation of some nutrients and the lack of others. The results indicate that leachate irrigation can generate a great accumulation of

Na and other elements in the aerial parts of the plants.Both of the materials contain sufficient amounts of plant nutrients. Leachate contains the amount of OM than that of town compost contains which is a superior fertilizing material than town compost. All nutrients were higher in Leachate .Soil fertility level at the experimental site was low.

This resulted in a good response of applied compost. Compost and leachate from municipal waste compost contain a variable combination of solutes, including inorganic ions such as CI, SO4 -2, Ca, Mg, Na and K, heavy metals and volatile/semi-volatile organic compounds (Clark and Piskin, 1977). It has been suggested urban waste compost leachate should be used as fertilizers in forest and grassland ecosystems because of their macro- as well as micronutrient supply (Hernttndez et al., 1999).

Residual plant nutrient contents in the soil after the crop harvest were found higher where town compost and leachate was applied. It could thus be concluded that compost and its leachate has valuable effects on the chemical properties of soil. The harvested crops had exhausted plant nutrients as indicated by lower Ca, Mg,P and K values in control plots than the values beforethe experiment. Increase in soil salinity is of special interest in semiarid and arid environments where salination of soils is rather more common as a consequence of high evapotranspiration. Under saline conditions, plants often exhibit stress (Hernttndez et al.,1999). Changes in plant growth and in macronutrient uptake are generally some of the principal effects. It is very significant, therefore, to interpret the relationship between salt treatment and nutrient balance because of the importance of nutrients in adaption to stress conditions (Lzzo et al., 1993). It is therefore necessary to determine the suitability of waste compost leachates for agrosystems irrigation by evaluating the influence of leachates on soils and plant uptake as well as other ecotoxicological effects. Surface water, groundwater and the surrounding soil may become polluted causing negative effects (such as bioaccumulation and toxicity) on biota (Hernttndez et al., 1999; Bundela et al., 2010).

Table 1: Some physical and chemical properties of the soil used

Soil Property	Quantity
Texture	Loam
PH	7.80 (1:1)
EC (dSm^{-1})	1.55 (1:5)
OC (%)	0.19
N (%)	0.07
Available P ($mg\ kg^{-1}$)	24
Available K($mg\ kg^{-1}$)	230
Fe ($mg\ kg^{-1}$)	2.42
Mn ($mg\ kg^{-1}$)	2.48
Zn ($mg\ kg^{-1}$)	1.10
Cu ($mg\ kg^{-1}$)	1.62
C d($mg\ kg^{-1}$)	0.032
Pb ($mg\ kg^{-1}$)	1.48
Ni ($mg\ kg^{-1}$)	0.11

Table 2: Some Chemical properties of the municipal waste compost leachate

Parameter	Unit	Quantity
PH		5.4
EC	(dSm^{-1})	28.5
OM	(%)	42
Dry Matter	(%)	4
N	(%)	0.21
P	($mg\ L^{-1}$)	83
K	($mg\ L^{-1}$)	1900
Na	($meq\ L^{-1}$)	95
Ca	($meq\ L^{-1}$)	125
Mg	($meq\ L^{-1}$)	20
$HCO3^{-1}$	($meq\ L^{-1}$)	400
Cl^{-1}	($meq\ L^{-1}$)	125
Fe	(meq L-1)	287.4
Mn	($meq\ L^{-1}$)	35.6
Zn	($meq\ L^{-1}$)	4.88
Ni	($meq\ L^{-1}$)	3.752

Table 3: Some chemical properties of the compost used

Parameter	Unit	Quantity
PH		6.44 (1:1)
EC	(dSm^{-1})	6.96 (1:5)
OC	(%)	11.68
N	(%)	1.42
P	($mg\ L^{-1}$)	0.29
K	($mg\ L^{-1}$)	1.18
Fe	($mg\ Kg^{-1}$)	3183
Mn	($mg\ Kg^{-1}$)	606.2
Zn	($mg\ Kg^{-1}$)	187.9
Cu	($mg\ Kg^{-1}$)	17.6
Cd	($mg\ Kg^{-1}$)	2.8
Pb	($mg\ Kg^{-1}$)	20.5
Ni	($mg\ Kg^{-1}$)	24.6

Table 4 : Effect of municipal waste compost leachate (MWCL) on some soil chemical properties

Soil properties		Treatment %(V/V MWCL/Water)			
		control	20	40	60
PH		8.2 a	8.1 b	7.9 c	7.6 d
EC	(dsm^{-1})	0.48 d	3.8 c	6.4 b	14.4 a
OC	(%)	0.09 d	0.24 c	0.37 b	0.64 a
$CaCO_3$	(%)	14.9 a	13.9 b	12.7 c	10.5 d
N	(%)	0.04 b	0.06 ab	0.09 ab	0.11 a
P	($mg\ L^{-1}$)	15.2 d	24.02c	38.7 b	54.15a
K	($mg\ L^{-1}$)	98 d	558 c	760 b	900 a
Na	($meq\ L^{-1}$)	9.2 d	15.3 c	27.6 b	33.3 a
Ca	($meq\ L^{-1}$)	2.8 d	10.7 c	21.8 b	52.5 a
Mg	($meq\ L^{-1}$)	3.1 d	7.8 c	13.8 b	37 a
$SO4^{-2}$	($meq\ L^{-1}$)	10.3 d	15.3 c	25.6 b	31.7 a
$HCO3^{-1}$	($meq\ L^{-1}$)	4.1 d	10.7 c	30.3 b	70.2 a
Cl^{-1}	($meq\ L^{-1}$)	5.3 d	17.7 c	30.2 b	60.7 a
Fe	(meq L-1)	6.7 d	93.2 c	125.3b	175.1a
Mn	($meq\ L^{-1}$)	12.2 d	46.3 c	49.5 b	57.9 a
Zn	($meq\ L^{-1}$)	4.09 d	5.35 c	6.37 b	7.20 a
Ni	($meq\ L^{-1}$)	0.7 d	1.6 c	2.2 b	3.1 a

Means with common letter in each column are not significantly different at $p<0.05$ according to Duncan Multiple Range Test

Table 5 :The effects of MWC on soil properties

Treatment ($t\ ha^{-1}$)	PH	EC (dsm^{-1})	OC (%)	N (%)	Available ($mg\ Kg^{-1}$)								
					P	K	Fe	Mn	Zn	Cu	Pb	Ni	Cd
Control	6.83 a	0.9 d	0.16 d	0.05 c	14 d	111 d	2.2 d	2.3 c	0.09 c	1.4 c	1.4 c	0.08 d	0.028 c
15	6.89 a	1.2 c	0.24 c	0.06 bc	33 c	123 c	2.4 c	2.4 b	1.1 b	1.5 b	1.5 b	0.1 c	0.045 bc
30	6.71 a	1.5 b	0.43 b	0.07 ab	53 b	143 b	2.5 b	2.5 a	1.5 a	1.83 a	1.6 b	0.2 b	0.047 ab
60	6.94 a	1.7 a	0.65 a	0.08 a	69 a	192 a	2.7 a	2.7 a	1.54 a	1.87 a	1.69 a	0.3 a	0.055 a

Means with common letter in each column are not significantly different at $p<0.05$ according to Duncan Multiple Range Test

Table 6: The effects of MWCL on concentrations of N, P, K and micronutrients / heavy metals and yield in corn

Treatment %(V/V, MWCL/Water)	Mean stem height (cm)	Dry matter weight (g)	Concentration (%)			Concentration ($mg\ kg^{-1}DM$)			
			N	P	K	Fe	Mn	Zn	Ni
Control	32 d	3.6 d	3 c	0.1 d	1 d	142c	99 d	13.9 c	0.2 d
20	40.7 c	6.2 c	4.4 c	0.4 c	1.7 c	176 c	125 c	14.8b	1.8 c
40	48.3b	7.4 b	5.4b	0.5 b	1.5 b	296 b	149 b	14.8ab	3.9 b
60	50.2 a	8.6 a	6 a	0.67 a	2 a	597 a	154 a	14.9 a	5.9 a

Means with common letter in each column are not significantly different at $p<0.05$ according to Duncan Multiple Range Test

Table 7: The effects of MWC on concentrations of N, P, K and concentrations of micronutrients / heavy metals and yield in corn

Treatment ($t\ ha^{-1}$)	Mean stem height (cm)	Dry matter (g)	Concentration (%)			Concentration ($mg\ kg^{-1}DM$)				
			N	P	K	Fe	Mn	Zn	Cu	Pb
Control	31 d	3.6 d	3 c	0.1 d	1 d	140 c	97 d	13.5 c	55d	0.2 d
15	38.7 c	6.2 c	3.4 c	0.2 c	1.2 c	166 c	105 c	14.5 b	61 c	1.9 c
30	44.5 b	6.8 b	4.5 b	0.3 b	1.4 b	256 b	129 b	14.7ab	68 b	3.3 b
60	49.2 a	7.3 a	5.3 a	0.37 a	1.6 a	517a	134a	14.9 a	71 a	5.1 a

Means with common letter in each column are not significantly different at $p<0.05$ according to Duncan Multiple Range Test

CONCLUSIONS

This study showed an increase in plant growth as well as an increase in the availability of certain nutrients. Waste compost Leachate is rich in plant nutrients and OM, and is acidic in pH. It may therefore be used as a liquid fertilizer especially in calcareous soils. Due to the high leachate salinity, frequent application and high rates are not recommended, especially for salt sensitive crops. It was demonstrated that the application of compost to soil improves some soil chemical properties. The nitrogen availability of the municipal compost is closely related to the maturity of this material. Sequential compost application can reduce inorganic N inputs for corn production, but must be balanced with P removal to avoid excessive soil P accumulation. In general, Agricultural utilization of MWC and MWCL is the most cost-effective management option over

traditional means such as landfilling or incineration as it enables recycling of potential plants nutrients Therefore physicochemical analysis of MWCL and MWC is necessary before its land application. Municipal waste leachate components is depend on municipal waste and garbage components that vary with seasons, places and time of the day. Compost components depend on what have used to make it. So withregard to variation of their sources, continuing the investigations on evaluating the effects of compost and municipal waste leachate on soil and plant properties, seem necessary. Compost application to soil has a positive effect on the microbial population and rhizosphere microorganisms and also contributes to the reduction of nematode populations in plants.However, when big doses of compost are used, an inhibitory effect on seed germination may appear. Therefore, more research is needed with different soil types and MWCL and MWC amendment rates to evaluate the effect of MWCL and MWC application on oilmicrobial biomass and reach the final conclusion

ACKNOWLEDGEMENTS

The authors would like to declare their appreciation of Tehran University for providing research facilities and Science and Research Khuzestan Branch of Islamic Azad University for supporting this research.

REFERENCES

Adani F, Genevini P, Tambone F, Montoneri E (2006) Compost effect on soil humic acid:A NMR study. Chemosphere. 65: 1414–1418.

Al-Jaloud A A, AI-Saati G H A, Karimullah S(1992) Effect of Wastewaters on plant growth and soil properties. Arid Soil Res.Rehabil. 7: 173-179 .

Andersson A (1977) Some aspects on the significance of heavy metals in sewage sludge and related products used as fertilizers. *Swedish J. Agric.* 7: 1-5.

Antoniadis V, Alloway B G (2003) Evidence of heavy metal movement down the profile of a heavily sludged soil. Commun. in Soil Sci. and Plant Anal. 34:1225-1231.

Arau´jo A S F, Santos V B, Monteiro R T R (2008) Responses of soil microbial biomass and activity for practices of organic and conventional farming systems in Piauı´ state. Brazil. Eur J Soil Biol. 44: 25–30.

Banin A, Narorot J (1981) Accumulation of heavy metals in arid-zone soils irrigated with treated sewage effluents. J. Environ.Qual. 10: 535-540.

Ben Achiba W, Gabteni N, Lakhdar A, Du Laing G, Verloo M, Jedidi N, Gallali T (2009) Effects of 5-year application of municipal solid waste compost on the distribution and mobility of heavy metals in a Tunisiancalcareous soil Agriculture. Ecosystems and Environment. 130 : 156–163.

Bengtson G W, Cornette J J (1973) Disposal of composted municipal waste in a plantation of young slash pine: Effects on soil and trees. J Enciron Q ual. 2: 441-4.

Bramryd T (1988) Leachate from landfills - avaluable fertilizer for revegetation of landfills with grass or energy forest. In ISWA Proceedings. 2: 61-68.

Bundela P S, Gautam S P, Pandey A K , Awasthi M K , Sarsaiya S (2010) Municipal solid waste management in Indian cities – Areview. International Journal of Environmental Science. 1: 591-606.

Cai Q Mo C, Wu Q, Zeng Q, Katsoyiannis A (2007) “Concentration and speciation of heavy metals in six different sewage sludgecompost. J Hazard Mater. 147:1063–1072.

Canellas L P, Santos GA, Rumjanek VM, Moraes A A, Guridi F (2001) Distribuicao da mate0ria organica e caracterısticas de acidos humicos em solos com a adicao de resıduos de origem urbana. Pesqui Agropecu Brasileira. 36: 1529–1538.

Castaldi P, Garau G, Melis P (2004) Influence of compost from sea weeds on heavy metal dynamics in the soilplant system. Fresen Environ Bull.13: 1322–1328.

Champan H D, Part P F (1961) Methods of Analysis for Soil, Plant and Water;University of California, Division of Agriculture Science: Riverside, CA.

Chanyasak V, Kubota H (1983) Source separation of garbage for composting.Bioo'cle.24: 56-8.

Chanyasak V, Hirai M, Kubota H (1982) Changes of chemical components and nitrogen transformation in water extracts during composting of garbage. J. Ferment.Technol. 60: 439-46.

Clark T P, Piskin R (1977) Chemical quality and indicator parameters for monitoring landfill leachate in Illinois. Environ. Geol. 1:329-339.

Cottenie A, Verloo M, Kickens L, Velghe G, Camerlynck R (1982) Chemical Analysis for Plant and Soil; Laboratory of Analytical and Agrochemistry, State University of Ghent: Belgium.Davis TL, Greig K, Kirkham M B (1988)Wastewater Irrigation of Vegetable. Crops.Biocycle. 29 : 60–63.

Diaz E, Lan A R (1994) Formation of stable aggregates in degraded soil by amendment with urban refuse and peat. Geoderma.63:277-288.

Epstein E (1975) Effect of sewage sludge on some soil physical properties. J. Environ.Qual.4:139-142.
Farrell M, Jones DL (2009) Critical evaluation of unicipal solid waste composting and potential compost markets. Bioresource Technology.100: 4301–4310.
Forbes E A, Posner A M, Quirk J P (1976) The adsorption of divalent Cd, Co, Pb in goethite. J. Soil Sci.27: 154-166.
Forbes E A, Posner A M, Quirk J P (1976) The Adsorption of Divalent Cd, Co, Pb and in Goethite. J. Soil Sci. 7: 154–166.
Gallardo-Lara F, Nogales R (1987) Effect of the Application of Town Refuse Compost on the Soil-Plant System: A Review.Biological Wastes. 19 : 35-62.
Gallardo-Lara F, Robles J, Esteban E, Azcon M , Nogales R (1984) Poder fertilizante de un compost de basura urbana. II. Efecto directoy residual sobre la asimilabilidad de Fe y Zn. In: Proceedings of I Congreso Nacional de la Ciencia del Suelo. Vol. I.,SECS, Madrid. 393-403.
Gillett J W (1992) Issues in risks assessment of compost from municipal solid waste:occupational health and safety, public health and environmental concerns.Biomass Bioenerg.3: 145–162.
Gray K R , Biddlestone A J (1980) Agricultural use of composted town refuse.In: *Inorganic pollution and agriculture.Proceedings of a Cot(erence organised bythe Agricultural Development and Advisoo"Service.* Ministry of Agriculture, Fisheries and Food, London. 279-305.
Guidi G , Plagliai M , Giachetti M (1982) Modifications of some physical and chemical soil properties following sludge and compost applications. In: The ip~uence of sewage sludge application on physical amt biological properties of soils. (Catroux,G., L'Hermite, P. & Suess, E. (Eds)),Dordrasht, The Netherlands. 122-30.
Hernttndez A J , Adarve M J , Gil A , Pastor j (1999) Soil salination from landfill leachates: effects on the macronutrient content and plant growth of four grassland species. Cheraosphere. 38: 1693-1711.
Hoffmann G (1983) Recycling of municipal waste compost in vineyard soils. In:Studies about humus. (Novak, B. (Ed)),Transactions of the VIH blternational Symposium. Vol. I. (Abstracts). Prague. 69.
Hue N V , Ranjith S A (1993) Sewage Sludges in Hawaii: Chemical composition and reactions with soils and plants, *Water, Air,Soil Pollul.* 72: 265-283.
Keonoh W (1978) Effects of organic materials on soil chemical properties. J. Lorean Soc.Soil Sci. Fert. 2: 161-74.
Khoshgoftarmanesh A H , Kalbasi M (2002) Effect of municipal waste leachate on soil properties and growth and yield of rice.COMMUN. SOIL SCI. PLANT ANAL. 33: 2011–2020 .
King L D , Leyshon A J , Webber L R (1977) Application of municipal refuse and liquid sewage sludge to agricultural land. II.Lysimeter study. J Era'iron Qual. 6: 67-7 I.
Korcak R F (1980) Effect of applied sewage sludge compost and fluidized bed material on apple seedling growth. Commun Soil Sci P Anal. 11:571-585.
Lakhdara A , Rabhia M , Ghnayaa T ,Montemurroc F , Jedidi N , Abdellya C (2009) Effectiveness of compost use in salt-affected soil. Journal of Hazardous Materials. 171: 29–37.

Lima J S , De Queiroz J E G , Freitas H B (2004) Effect of selected and non-selected urban waste compost on the initial growth of corn. Resources, Conservation and Recycling. 42 :309–315.
Lindsay W L , Norvell W A (1978) Development of a DTPA soil test for Zinc.Iron, manganese, and copper. Soil Sci. Soc.Am. J. 42:421-428.
Lzzo R A , Scagnozzi A , Navari-lzzo F (1993) lnfluence of NaC1 treatment on Ca, K and Na interrelations in maize shoots. In Optimization of Plant Nutrition (Edited by.M. A. C. Fragoso and M. L. Van Beusichem). luwer Academic Publisher,the Netherlands . 577-582.
Mortvedt J J , Giordano P M (1975) Response of corn to zinc and chromium in municipal wastes applied to soil. *J. Environ. Qual.* 4:170-174.
Nogales R , Gomez M , Gallardo-Lara F (1985b) Town refuse compost as a potential source of zinc for plants. In: *Proceedings of International Conference of Heavy Metals in the Environment.* (Lekkas, T. D. (Ed.)).Vol. 1, Athens. 487-489.
Olsen S R , Sommers L E (1990) Phosphorus.In Methods of Soil Analysis, Agron. Monogr., 2nd Ed.; Page, A.L., Ed.; Part 2,ASA: Madison, WI. 403–431.
Pan F , McLaughlin N B , Yu Q , Xue A G ,Xu Y , Han Z , Li C , Zhao D (2010) Responses of soil nematode community structure to different long-term fertilizer strategies in the soybean phase of a soybean-wheat-corn rotation. EuropeanJournal of Soil Biology. 46:105-111.
Pedra F , Polo A , Ribeiro A , Domingues H (2007) Effects of municipal solid waste compost and sewage sludge on mineralization of soil organic matter. Soil Biol Biochem. 39: 1375–1382.
Prechthai T , Parkpian P , Visvanathan C (2008) Assessment of heavy metal contamination and its mobilization from municipal solid waste open dumping site Journal of Hazardous Materials. 156 : 86–94.
Rahimi G H (1995) Effect of Garbage Compost on Salinity and Pollution of Soil and Uptake of Heavy Metals by Corn Grown on Soils Treated by Compost. WSC Thesis,College of Agriculture, Isfahan University of Technology, Isfahan, Iran.
Smith J H , Hayden C W (1984) Nitrogen availability from potato-processing wastewater for growing corn. J. Environ.Qual. 13:151-156.
Sposito G L , Lund J , Chang A C (1982) Trace metal chemistry in arid-zone field soils amended with sewage sludge: fractionation of Ni, Cu, Zn, Cd. and Pb in solid phases.Soil Sci. Soc. Am. J. 46: 260-264.
Stark S A , Clapp C E (1980) Residual nitrogen available from soils treated with sewage sludge in a field experiment. J. Environ.Qual. 9: 512-515.
Stephen R S (2009) A critical review of the bioavailability and impacts of heavy metals in municipal solid waste composts compared to sewage sludge. Environment International. 35 : 142–156.
Sterrett S B , Chaney R L (1982) Transplant quality and metal concentrations in vegetable transplants grown in media containing sewage sludge compost.Hortscience. 17: 920-922.
Sutton A L , Nelson D W , Marose V B , Nye J C (1978) Effects of household compost on soil chemical composition. J. Environ.Qual. 13: 132-136.

Sutton A L , Nelson D W , Mayrose V B , Nye J C (1978) Effects of Liquid Swine Waste Applications on Corn Yield and Soil hemical Composition. J. Environ. Qual. 7: 325–333.

Takeda M , Nakamot T , Miyazawa K ,Murayama T , Okada H (2009) Phosphorus availability and soil biological activity in an Andosol under compost application and winter cover cropping.Applied Soil Ecology. 42: 86–95.

Trierweiler J F , Lindsay W L (1969) EDTAAmmonium carbonate soil test for zinc.Soil Soc. Amer. Proc. 33: 49-59.

Vaisman I , Shalevet G , Kipnis T , Feigin A (1981) Reducing ground water pollution from municipal waste water Irrigation of Rhodes grass grown on sand dunes.J.Environ. Qual. 10:234-236.

Wong M H (1985) Phytotoxicity of refuse compost during the process of maturation. Environ. Pollut., Ser. A. 37 : 159-74.

Wong M H , Chu L M (1985) The response of edible crops treated with extracts of refuse compost of different ages. Agricultural Wastes. 14: 63-74.

Zupanc V , Zupanc J M (2010) Changes in soil characteristics during landfill leachate irrigation of Populus deltoids. Waste Management. 30: 2130–2136.